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TI Tin-based solders having low melting point
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PA Fukuda Metal Foil Powder, Japan
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AB The Sn solders contain P 0.05-1.5, Ni 0.5-5.0, and optionally Cu ≤30 and/or Ag ≤10, but (Ni + Cu + Ag) ≤35%. The solders have high wettability and fluidity and are suitable for vacuum-soldering stainless steel at 500-600°.

FULL CONTENTS

[Claim(s)]
[Claim 1] P 0.05-1.5 Weight % and nickel 0.5-5.0 Sn machine low-melt point point brazing material which consists of weight %, the remainder Sn, and an inevitable impurity.
[Claim 2] P 0.05-1.5 Weight % and nickel 0.5-5.0 Sn machine low-melt point point brazing material which the sum of nickel, Cu, and Ag becomes from Remainder Sn and an inevitable impurity 35 or less weight % by weight %, 30 or less weight % of Cu(s), or/and 10 or less weight % of Ag.

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to outstanding Sn machine low-melt point point brazing material of the wettability for using it, when carrying out vacuum brazing of the stainless steel which forms a firm oxide film in a metal comrade, especially the surface, and flowability.
[0002]
[Description of the Prior Art] heat-resistant nickel wax (BNi-1-7 and JIS Z 3265) and Ag wax (BAg-1-8, JIS Z3261) which were conventionally specified for brazing of stainless steel at JIS etc. -- it is used. [are the alloy which nickel wax uses nickel as a principal component, and contains Cr, B Si, P, etc., since it has autogenous welding nature it is not necessary to use flux and can manufacture good brazing components by vacuum brazing etc. but] Since the fusing point is high, a high 1000-degree-C (BNi-6, 7) - brazing temperature of 1200 degrees C (BNi-5) is required. Ag wax is Ag-Cu. Although it is the alloy composition which considers it as a principal component and contains Zn, Cd, nickel,

Sn, etc. in this and a fusing point can also be brazed at 650 degrees C - 900 degrees C comparatively low, since there is no autogenous welding nature, it is necessary to use flux, and since Zn with a high vapor pressure is included so much, it is not suitable for vacuum brazing.
[0003] Solder, such as Sn-Pb, Sn-Ag, Sn-Pb-Ag, and Sn-Pb-Sb (JIS H 4341 etc.) (although a fusing point is as low as about 200 ** and is used also as an object for stainless steel) Since flux is needed, like Ag wax, in vacuum brazing, wettability with stainless steel is bad and cannot obtain good brazing components. As mentioned above, it sets to brazing of the stainless steel which forms a firm oxide film in the surface. Sensitization temperature of stainless steel (abbreviation 650 degrees C) The following or annealing softening starting temperature of cold working material (18-8 stainless steel: based on about 600 degrees C and a 25Cr steel:about 500-degree-C; stainless steel handbook) Following, namely, -- When the brazing material which demonstrates good wettability by vacuum brazing etc. without flux at the temperature of 600 degrees C or less is needed, in a conventional brazing material or solder, it cannot attain the above-mentioned object in respect of a fusing point or wettability.
[0004]
[Problem to be solved by the invention] The object of this invention is stainless steel which forms a firm oxide film in the surface. It is 500-600-degree C low temperature, is vacuum brazing which moreover cannot use flux, and is offering the low-melt point point brazing material which is not in the former which a constituent element's does not evaporate but demonstrates good wettability and flowability.
[Means for Solving the Problem]
[0005] This invention persons are 500-600-degree C low temperature about the stainless steel which forms a firm oxide film in the surface. The result which has advanced investigation of various base components and an addition ingredient in order that it can braze without using flux, and wettability may find good brazing-material alloy composition, As a base component, a fusing point in a practical use metal It is as the lowest as 232 degrees C, and a vapor pressure is also comparatively low. (between Ag and Cu(s)) Moreover, it was nonpoisonous, and corrosion resistance was good and chose Sn which is stable also in price. As a result of examining the effect of various elements as an addition ingredient to this, by adding a little P, the oxide film with the firm stainless steel base material surface was destroyed by autogenous welding nature exertion in a brazing process, and it found out that wettability improved. Moreover, by adding nickel to this, evaporation of P in a vacuum brazing process was controlled, and it found out that there was an effect which lessens contamination of a furnace or the exhaust. Furthermore, the flowability of the brazing material in a brazing process improves further by adding Cu or Ag to this. Cu and Ag complete this invention by [each] limiting independent or the range of an addition ingredient which finds out that compound addition is possible and demonstrates good wettability by 600-degree-C brazing.
[0006] That is, this invention is (1). P 0.05 -1.5 Weight % and nickel 0.5-5.0 Sn machine low-melt point point brazing material which consists of weight %, the remainder Sn, and an inevitable impurity.

(2) P 0.05 -1.5 Weight % and nickel 0.5-5.0 Weight % and Cu 30 The sum of nickel, Cu, and Ag is Sn machine low-melt point point brazing material which consists of the remainder Sn and an inevitable impurity 35 or less weight % in below weight % or/and 10 or less weight % of Ag.

[0007]

[Function] In this invention, the Reason which limited each component range like the above is explained below. P is phosphide with each component by adding and alloying to this brazing material. (Sn_4P_3, nickel3P, Cu_3P, AgP, etc.) although it is effective in improving wettability by forming, demonstrating autogenous welding nature in a brazing process, and destroying an oxide layer with the firm stainless steel surface the effect is not demonstrated at less than 0.05% -- if 1.5% is exceeded, while the above-mentioned effect will become slow, the danger of evaporation of P in a vacuum brazing process arises. For this reason, the addition range of P was limited with 0.05 - 1.5 %.

[0008] [nickel has the effect which controls evaporation of P at the time of vacuum brazing while it fabricates stable nickel3P etc. and demonstrates autogenous welding nature by adding and alloying to this brazing material, but] 0.5 if there are few the effects under at % and 5.0 % is exceeded -- fusing point of an alloy (liquidus temperature) Temperature (600 degrees C or more) which is not desirable up to -- it will go up. For this reason, the addition range of nickel was limited with 0.5 - 5.0 %.

[0009] Sn-P-nickel although stable vacuum brazing in which it has wettability also with a good ternary alloy, and P does not evaporate can be performed It is Sn-P-nickel by adding Cu and Ag to this. Liquidus temperature falls rather than a ternary alloy, and it is effective in wax flare nature, i.e., the flowability of a brazing material, improving further. Cu and Ag demonstrate the above-mentioned effect that each independent addition or compound addition is also the same. However, if the case of Cu addition exceeds 30%, liquidus temperature will rise and melt into 600 degrees C or more, and will become easy to produce poor brazing, such as separation. If it exceeds 10% in Ag addition, the toughness of a brazing material will fall and a brazing part will break easily. Moreover, when carrying out compound addition of Cu and Ag, if the sum of nickel, Cu, and Ag exceeds 35%, the above-mentioned defect will arise. For this reason, Cu limited with 30% or less, and, in addition, Ag both limited the sum of nickel, Cu, and Ag with 35% or less 10% or less, respectively.

[0010] Although contained about 65% or more as a base component of this invention, it forms a fluid good brazing-material alloy by combining with Cu or Ag while it suppresses a fusing point low, and combines with P and nickel and demonstrates autogenous welding nature, even if Sn alloys the above-mentioned addition ingredient from the lowness of the fusing point of Sn itself. Sn machine low-melt point point brazing material of this invention is possible also for being able to fabricate and use it for the form of the powder by the usual gas atomizing method etc., a foil, a line, etc., and applying to brazing of base materials other than stainless steel, and useful.

[0011]

[Working example] the alloy composition of the example of this invention, and a fusing point -- and --

The brazing test result in 600 degrees C and P analysis result after heating are shown in Table 1, and the alloy composition and each test result of a comparative example are shown in Table 2. In addition, the measuring method of a fusing point, a brazing test method, and the P analysis method after heating are as follows.

(1) The alloy of the fusing point (liquidus, solidus) measurement example and the comparative example was dissolved within an electric furnace and in an argon gas atmosphere, and the fusing point was measured by thermal analysis. That is, the thermal-analysis curve was made to draw on the recorder connected with the thermocouple inserted in the molten metal center section, and each temperature of the liquidus and the solidus was read in the cooling curve.

[0012] (2) The alloy of the brazing check example and the comparative example was dissolved within an electric furnace and in an argon gas atmosphere, the molten metal was cast to the graphite mold, the rod-like casting piece of 5mmphi was obtained, it was cut in height of about 5mm, and it was considered as the brazing-material specimen. next, drawing 1 (a) a brazing-material specimen is carried on a SUS304 stainless-steel base material so that it may be shown -- brazing heat treatment (henceforth brazing) was performed in the vacuum of a 10-4torr base for 30 minutes at 600 degree C. After brazing and drawing 1 (b) The area S which the brazing material melted and spread so that it might be shown is measured. The numerical value W which broke the area S by the cross-section area So of the brazing-material specimen before brazing, i.e., a wax flare multiplier, (=S/So) was calculated, and it was considered as the wettability and the fluid index to the SUS304 stainless-steel base material of a brazing-material alloy.

[0013] Moreover, drawing 1 (c) 90 degrees of brazing specimens were bent, the condition of debonding at that time was investigated, and the adhesion force to the SUS304 stainless-steel base material of a brazing-material alloy was evaluated so that it might be shown. In addition, adhesion force assessment shown in front was performed on the following basis.

adhesion force (90-degree bending) not doing O; debonding of -- O; -- a part -- edge debonding x; complete debonding (3) Alloy of P analysis example after heating, and a comparative example (No.a-e) The brazing-material specimen obtained by the same method as (2) brazing checks was put into the magnetic combustion boat, and it heat-treated on the same conditions as a brazing check. In this way, quantitative analysis of the amount of P of the brazing-material alloy after obtained heating was carried out with the method of chemical analysis. The value lengthened from the amount of P of the brazing material before heating this value, i.e., P decrease, was calculated, and the behavior in the brazing process of P with high possibility of evaporating most among a brazing-material alloy was investigated.

[0014]

[Table 1]

表1

	No	合金組成（重量%）					融点（℃）		600℃ろう付		600℃加熱	
		Sn	P	Ni	Cu	Ag	固相線	液相線	ろう拡がり係数 W	付着力（90°曲げ）	P分析値（wt%）	P減少量（wt%）
実施例合金	1	残	0.05	0.5	−	−	230	300	3.8	○	0.04	0.01
	2	残	0.32	3.0	−	−	230	500	6.5	◎	0.32	0
	3	残	0.54	2.4	−	−	230	510	7.8	◎	0.49	0.05
	4	残	1.08	4.7	−	−	230	575	7.2	◎	1.05	0.03
	5	残	0.27	2.0	3.0	−	220	550	8.1	◎	0.25	0.02
	6	残	0.54	2.4	5.0	−	223	480	9.2	◎	0.49	0.05
	7	残	0.50	2.5	20.0	−	225	590	22.0	◎	0.49	0.01
	8	残	0.78	2.4	2.5	−	223	500	11.7	◎	0.77	0.01
	9	残	0.78	2.4	7.5	−	225	470	19.2	◎	0.76	0.02
	10	残	1.07	4.8	9.9	−	223	550	20.7	◎	1.05	0.02
	11	残	1.50	5.0	30.0	−	222	600	30.0	◎	1.47	0.03
	12	残	0.92	5.0	−	10.0	217	470	5.2	○	0.90	0.02
	13	残	0.27	2.0	8.0	10.0	220	515	18.8	○	0.27	0
	14	残	0.53	2.4	5.0	4.8	215	450	9.0	◎	0.53	0
	15	残	0.77	2.4	7.5	4.8	215	450	17.7	◎	0.75	0.02
	16	残	1.06	4.8	10.0	9.7	210	530	17.7	○	1.06	0
	17	残	1.50	5.0	20.0	10.0	215	560	30.0	◎	1.50	0

[0015] As shown in Table 1, it is the example alloy of this invention. In a brazing check at 600 degrees C, all are understood that a wax flare multiplier is large, adhesion force is also good, and the wettability and flowability to a SUS304 stainless-steel base material are good. Moreover, P decrease after 600 degree-C heating It is dramatically as small as 0 to 0.05%, and it turns out that P hardly evaporates in a brazing process. In addition, this example alloy Also in a brazing check at 500 degrees C, it is checking that good brazing nature is shown.

[0016]

[Table 2]

表2

		合金組成（重量%）						融点（℃）		600℃ろう付		600℃加熱	
	No	Sn	P	Ni	Cu	Ag	Pb	固相線	液相線	ろう拡がり係数 W	付着力（90°曲げ）	P分析値（wt%）	P減少量（wt%）
比較例合金	a	残	0.25	–	5.0	–	–	227	407	8.7	◎	0.05	0.20
	b	残	0.48	–	5.1	–	–	225	433	9.8	◎	0.03	0.45
	c	残	0.47	–	10.0	10.0	–	220	383	14.6	◎	0.10	0.37
	d	残	0.03	0.3	–	–	–	230	230	2.0	×	0.03	0
	e	残	1.0	6.0	–	–	–	230	650	1.5	×	0.98	0.02
	f	残	–	–	10.0	–	–	220	419	1.6	×		
	g	残	–	–	30.0	–	–	222	582	2.0	×		
	h	残	–	–	24.0	6.0	–	218	540	1.8	×		
	i	残	6.5	–	73.5	–	–	560	805	1.0	×		
	j	–	–	–	28	72	–	780	780	1.0	×		
	k	60	–	–	–	–	40	183	183	2.0	×		
	l	95	–	–	–	–	5	183	223	1.6	×		
	m	95	–	–	–	5	–	221	221	2.5	×		

[0017] on the other hand, it sets into the comparative example alloy shown in Table 2 -- No.a-i is the presentation from which it separated from the range of this invention alloy, among those No.a-c is a presentation in which P, Cu, and Ag do not contain nickel in the range of this invention. In this case, although brazing nature is good, the danger of there being many P decreases, and most P evaporating in a brazing process, and polluting a furnace and evacuation equipment is large. The P evaporation reduction effect of nickel in this invention alloy is clear also from this point.
[0018] No.d-i is these although it is the presentation from which P and nickel mainly separated from the range of this invention alloy. It turns out [which are cursed by 600 degree-C brazing check] that it spreads, and a multiplier is small, and adhesion force is also poor, and can hardly be applied to a SUS304 stainless-steel base material. Also from this point The wettability improvement effect over the stainless steel base material of P in this invention alloy is clear. BAg-8 as which No.j is specified to JIS, Ag wax alloy, and No.k-m . although it is the conventional alloy of Sn-Pb or Sn-Ag solder It turns out that it cannot braze at 600 degrees C in respect of a fusing point in the case of Ag wax, and it can hardly apply to a SUS304 stainless-steel base material even if it brazes at 600 degrees C although a fusing point is lower than an example alloy in the case of solder.
[0019] In addition, it is a liquidus as a feature of the fusing point of Sn machine low-melt point point brazing material of this invention. It is primary phase crystallization temperature, such as nickel3P and nickel-Cu (Ag), and a solidus is the eutectic temperature of them and Sn and appears in common with near 220 degree C. The width of a solidus and a liquidus changes with presentations and the width Although it became 200 degrees C or more in many cases, as a result of observing the alloy organization after brazing, crystallized material was uniformly distributed in the host phase, the systematic bias was not seen, and the trace all melt and it becomes poor brazing of separation, void,

etc. was not seen.

[0020] Moreover, as a result of observing the joining interface of the brazing specimen of an example by EPMA etc., it checked that it is returned by P in a brazing material, and Cr of the stainless steel base material surface and Fe oxide film were not seen at all, and did not have traces, such as debonding by a joining interface,, either, and the brazing material and the base material had joined them good.

[0021]

[Effect of the Invention] As mentioned above, as explained in full detail, [Sn machine low-melt point point brazing material of this invention] The stainless steel which forms a firm oxide film in the surface [500-600-degree C low temperature] And size is [place which vacuum brazing can be carried out without using flux, P which is the element which evaporates easily in an architecture component does not evaporate, but has the effect of demonstrating good wettability and flowability, and contributes to development of industry] becoming invention.

[Brief Description of the Drawings]

[Drawing 1] It is a mimetic diagram for explaining the brazing check of a brazing material.

[Explanations of letters or numerals]

So: The cross-section area of a brazing-material specimen

S : flare area of the alloy after brazing

W : brazing flare multiplier (S/So)

1 : Base Material (SUS304 Stainless Steel)

2 : Brazing-Material Specimen before Brazing (5PhiX about 5Mm)

3 : Brazing-Material Alloy Which it Melted after Brazing and Spread

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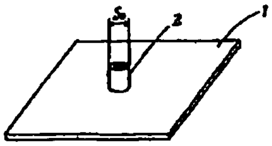
[Drawing 1]

(a)



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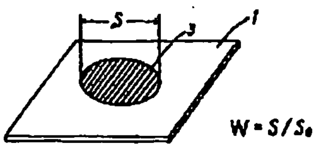

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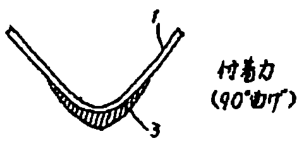

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[Translation done.]